AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1.   (Currently Amended) A face detection and tracking system for detecting and tracking a plurality of faces in real time from an input image, the system comprising:

a background removing unit which extracts an area having a motion by removing ~~the~~ a background image from the input image;

a candidate area extracting unit which extracts a candidate area in which a face is possibly located in the area having a motion[[,]] by using a skin color probability map (P_{skin}) generated from a face skin color model and ~~the~~ a global probability map (P_{global});

a face area determination unit which extracts independent component analysis (ICA) features from [[a]] the candidate area and determines whether ~~or not~~ the candidate area is a face area; and

a face area tracking unit which tracks [[a]] the face area according to a directional kernel indicating a probability that a face is located in a next frame[[,]] based on the skin color probability map (P_{skin}).

2.   (Currently Amended) The system of claim 1, wherein the candidate area extracting unit comprises:

a skin color probability map generation unit which generates [[a]] the skin color probability map (P_{skin}) of the area having a motion[[,]] by using [[a]] the face skin color model;

a global probability map generation unit which extracts a plurality of highest points of the area having a motion, sets central coordinates at a predetermined distance from the plurality of highest points, and calculates a probability that a face is located within a distance from the central coordinates[[,]] to generate [[a]] the global probability map (P_{global}); and

a multiple scale probability map generation unit which generates a multiple scale probability map about the probability that a face is located, by multiplying the skin color probability map (P_{skin}) and the global probability map (P_{global}), and extracts an area, in which the probability value of the generated multiple scale probability map is equal to or greater than a predetermined threshold value, as [[a]] the candidate area where a face is possibly located.

3.   (Currently Amended) The system of claim 2, wherein the skin color probability map generation unit converts the a color of each pixel in the area having a motion into hue and saturation values, and applies the values to [[a]] the face skin color model which is a 2-dimensional Gaussian model that is trained in advance with a variety plurality of skin colors, to generate [[a]] the skin color probability map (P_{skin}) indicating a probability that the color of an the area having a motion is [[a]] one of the plurality of skin color colors.

4.   (Currently Amended) The system of claim 3, wherein when Hue(i,j) and Sat(i,j) denote the hue and saturation <u>values</u> at coordinates (i,j) of the area having a motion, respectively, $\vec{u}$ and Σ denote ~~the~~ average and distribution of Gaussian dispersion, respectively, and ~~the~~ <u>a</u> size of a face desired to be searched for is n, the skin color probability map $P_{skin}(x,y,n)$ is generated according to the following equation:

$$P_{skin}(x,y,n) = \frac{\sum\limits_{i=x-n/2}^{i=x+n/2} \sum\limits_{j=y-n/2}^{j=y+n/2} g(Hue(i,j),Sat(i,j);\vec{u},\Sigma)}{n^2}$$

5.   (Currently Amended) The system of claim 2, wherein when $\vec{u}_i$ denotes the central coordinates of the candidate area, Σ denotes a dispersion matrix, n denotes ~~the~~ <u>a</u> size of a face area, and (x_i, y_i) denotes the coordinates of each local area (i), the global probability map generation unit gener$\underset{.}{a}$tes <u>the</u> global probability map $P_{global}(x,y,n)$ according to the following equation:

$$P_{global}(x,y,n) = \sum\limits_{i=1}^{N} g(x_i, y_i; \vec{u}_i, \Sigma)$$

where $\vec{u}_i$, Σ, x_i, and y_i satisfies the following equations, respectively:

$$\vec{u}_i = \begin{pmatrix} u_{ix} \\ u_{iy} \end{pmatrix} = \begin{pmatrix} m_{ix} + n\cos(\angle(-\vec{n}(m_i))) \\ m_{iy} + n\sin(\angle(-\vec{n}(m_i))) \end{pmatrix}, \quad \Sigma = \begin{pmatrix} n^2 & 1.5n^2 \\ 1.5n^2 & (1.5n)^2 \end{pmatrix}.$$

$$\begin{pmatrix} x_i \\ y_i \end{pmatrix} = \begin{pmatrix} \cos(\angle(\vec{n}(m_i))) & -\sin(\angle(\vec{n}(m_i))) \\ \sin(\angle(\vec{n}(m_i))) & \cos(\angle(\vec{n}(m_i))) \end{pmatrix} \cdot \begin{pmatrix} x - u_{ix} \\ y - u_{iy} \end{pmatrix}$$

6.   (Currently Amended) The system of claim 1, wherein the face area determination unit comprises:

an ICA feature extracting unit which extracts features by performing ICA on the extracted face candidate area; and

a face determination unit which determines whether ~~or not~~ the candidate area is a face[[,]] by providing the ICA features of the candidate area to a support vector machine (SVM) which has learned features obtained by performing ICA on learning face images and features obtained by performing ICA on images that are not [[a]] face images.

7.   (Currently Amended) The system of claim 1, wherein when it is assumed that ~~the~~ coordinates at which the center of a face is to be located[[,]] and ~~the~~ dispersion are (μ_x, μ_y) and (σ_x,σ_y), respectively, and

$\overline{\sigma}_x^2 = 2(\sigma_x^2 + \Delta\mu_x^2), \quad \overline{\sigma}_y^2 = 2(\sigma_y^2 + \Delta\mu_y^2), \quad Z_x = \dfrac{x - \mu_x}{\sigma_x}, Z_y = \dfrac{x - \mu_y}{\sigma_y}$, if the probability that a

face is located is $f(x,y,\sigma_x,\sigma_y) = \dfrac{1}{S} \cdot \exp\left\{\dfrac{-(Z_x^2 - 2\sigma_{xy}Z_xZ_y + Z_y^2)}{2(1 - \sigma_{xy}^2)}\right\}$, the ~~direction~~

directional kernel is expressed as $f(x,y,\sigma_x,\sigma_y)$ in ~~the~~ a direction in which the face area moves, and expressed as $f(x,y,\overline{\sigma}_x,\overline{\sigma}_y)$ in ~~the~~ an opposite direction.

8.   (Currently Amended) The system of claim 1, wherein the background removing unit obtains a first area which is not a background[[,]] by using ~~the~~ a brightness difference of the input image and a background image stored in advance,

and obtains a second area which is not the background[[,]] by using ~~the~~ a color

difference of the ~~two images~~ the input image and the background image stored in

advance, and among a plurality of sub-areas included in the second area that is not

the background, ~~and~~ extracts each sub-area which includes the center of a sub-area

included in the first area that is not the background[[,]] as areas that are not the

background, to remove the background image from the input image and extract an

area having a motion.

9.   (Currently Amended) The system of claim 8, wherein the background

removing unit updates a new background image R'(x,y) according to the following

equation:

$$R'(x,y) = \beta R(x,y) + (1-\beta)B(x,y)$$

where R(x,y) denotes an existing background image, B(x,y) denotes a binary image

in which an area having a motion is removed ~~form~~ from the input image, and β

denotes an update constant.

10.   (Currently Amended) A face detection and tracking system for

detecting and tracking a plurality of faces in real time from an input image, the

system comprising:

a background removing unit which obtains a first area which is not a

background[[,]] by using ~~the~~ a brightness difference of ~~an~~ the input image and a

background image stored in advance, and obtains a second area which is not the

background[[,]] by using ~~the~~ a color difference of the ~~two images~~ input image and the

background image stored in advance, and among a plurality of sub-areas included in the second area that is not the background, and extracts each sub-area which includes the center of a sub-area included in the first area that is not the background, as areas that are not background, to remove the background image from the input image and extract an area having a motion;

a skin color probability map generation unit which generates a skin color probability map (P_{skin}) of the area having a motion, by using a face skin color model;

a global probability map generation unit which extracts a plurality of highest points of the area having a motion, sets central coordinates at a predetermined distance from the plurality of highest points, calculates a probability that a face is located within a predetermined distance from the central coordinates, to generate a global probability map (P_{global});

a multiple scale probability map generation unit which generates a multiple scale probability map about the probability that a face is located[[,]] by multiplying the skin color probability map (P_{skin}) and the global probability map (P_{global}), and extracts an area, in which the probability value of the generated multiple scale probability map is equal to or greater than a predetermined threshold value, as a candidate area where a face is possibly located;

a face area determination unit which extracts independent component analysis (ICA) features from [[a]] the candidate area and determines whether or not the candidate area is a face area[[,]] by providing the ICA features of the candidate area to a support vector machine (SVM) which has learned features obtained by performing ICA on learning face images and features obtained by performing ICA on images that are not [[a]] face images; and

a face area tracking unit which tracks a face area according to a directional kernel indicating a probability that a face is located in a next frame, based on the skin color probability map (P_{skin}).

11.   (Currently Amended) A face detection and tracking method for detecting and tracking a plurality of faces in real time from an input image, the method comprising:

(a) extracting an area having a motion by removing ~~the~~ a background image from the input image;

(b) extracting a candidate area in which a face is possibly located in the area having a motion[[,]] by using a skin color probability map (P_{skin}) generated from a face skin color model and a global probability map (P_{global});

(c) extracting independent component analysis (ICA) features from a candidate area and determining whether ~~or not~~ the candidate area is a face area; and

(d) tracking [[a]] the face area according to a directional kernel indicating a probability that a face is located in a next frame, based on the skin color probability map (P_{skin}).

12.   (Currently Amended) The method of claim 11, wherein step (b) comprises:

(b1) generating [[a]] the skin color probability map (P_{skin}) of the area having a motion[[,]] by using [[a]] the face skin color model;

(b2) extracting a plurality of highest points of the area having a motion, setting central coordinates at a predetermined distance from the plurality of highest points, and calculating a probability that a face is located within a predetermined distance from the central coordinates, to generate [[a]] the global probability map (P_{global}); and

(b3) generating a multiple scale probability map about the probability that a face is located[[,]] by multiplying the skin color probability map (P_{skin}) and the global probability map (P_{global}), and extracting an area, in which the probability value of the generated multiple scale probability map is equal to or greater than a predetermined threshold value, as [[a]] the candidate area where a face is possibly located.

13.   (Currently Amended) The method of claim 12, wherein in step (b1) ~~the~~ color of each pixel in the area having a motion is converted into hue and saturation values and the values ~~is~~ are applied to [[a]] the face skin color model, which is a 2-dimensional Gaussian model that is trained in advance with a ~~variety~~ plurality of skin colors, to generate [[a]] the skin color probability map (P_{skin}) indicating a probability that the color of an area having a motion is [[a]] one of the plurality of skin ~~color~~ colorss.

14.   (Currently Amended) The method of claim 13, wherein when Hue(i,j) and Sat(i,j) denote the hue and saturation values at coordinates (i,j) of the area having a motion, respectively, $\bar{u}$ and Σ denote ~~the~~ average and distribution of Gaussian dispersion, respectively, and ~~the~~ a size of a face desired to be searched for is n, the skin color probability map $P_{skin}(x,y,n)$ is generated according to the following equation:

$$P_{skin}(x,y,n) = \frac{\sum\limits_{i=x-n/2}^{i=x+n/2} \sum\limits_{j=y-n/2}^{j=y+n/2} g(Hue(i,j),Sat(i,j);\vec{u},\Sigma)}{n^2}$$

15. (Currently Amended) The method of claim 12, wherein in step (b2), when $\vec{u}_i$ denotes the central coordinates of the candidate area, Σ denotes a dispersion matrix, n denotes ~~the~~ a size of a face area, and (x_i,y_i) denotes the coordinates of each local area (i), the global probability map $P_{global}(x,y,n)$ is generated according to the following equation:

$$P_{global}(x,y,n) = \sum_{i=1}^{N} g(x_i,y_i;\vec{u}_i,\Sigma)$$

where $\vec{u}_i$, Σ, x_i, and y_i ~~satisfies~~ satisfy the following equations, respectively:

$$\vec{u}_i = \begin{pmatrix} u_{ix} \\ u_{iy} \end{pmatrix} = \begin{pmatrix} m_{ix} + n\cos(\angle(-\vec{n}(m_i))) \\ m_{iy} + n\sin(\angle(-\vec{n}(m_i))) \end{pmatrix}, \quad \Sigma = \begin{pmatrix} n^2 & 1.5n^2 \\ 1.5n^2 & (1.5n)^2 \end{pmatrix}.$$

$$\begin{pmatrix} x_i \\ y_i \end{pmatrix} = \begin{pmatrix} \cos(\angle(\vec{n}(m_i))) & -\sin(\angle(\vec{n}(m_i))) \\ \sin(\angle(\vec{n}(m_i))) & \cos(\angle(\vec{n}(m_i))) \end{pmatrix} \cdot \begin{pmatrix} x - u_{ix} \\ y - u_{iy} \end{pmatrix}$$

16. (Currently Amended) The method of claim 11, wherein step (c) comprises:

extracting features by performing ICA on the extracted face candidate area; and

determining whether ~~or not~~ the candidate area is a face[[,]] by providing the ICA features of the candidate area to a support vector machine (SVM) which has learned features obtained by performing ICA on learning face images and features obtained by performing ICA on images that are not [[a]] face images.

17.　(Currently Amended)　The method of claim 11, wherein when it is assumed that the coordinates at which the center of a face is to be located[[,]] and the dispersion are (μ_x, μ_y) and (σ_x,σ_y), respectively, and

$$\bar{\sigma}_x^2 = 2(\sigma_x^2 + \Delta\mu_x^2), \quad \bar{\sigma}_y^2 = 2(\sigma_y^2 + \Delta\mu_y^2), \quad Z_x = \frac{x - \mu_x}{\sigma_x}, Z_y = \frac{x - \mu_y}{\sigma_y},$$ if the probability that a

face is located is $f(x, y, \sigma_x, \sigma_y) = \frac{1}{S} \cdot \exp\left\{ \frac{-(Z_x^2 - 2\sigma_{xy}Z_xZ_y + Z_y^2)}{2(1 - \sigma_{xy}^2)} \right\}$, the ~~direction~~

directional kernel is expressed as $f(x, y, \sigma_x, \sigma_y)$ in ~~the~~ a direction in which the face area moves, and expressed as $f(x, y, \bar{\sigma}_x, \bar{\sigma}_y)$ in ~~the~~ an opposite direction.

18.　(Currently Amended)　The method of claim 11, wherein in step (a), a first area which is not a background is obtained by using ~~the~~ a brightness difference of the input image and a background image stored in advance, and a second area which is not the background is obtained by using ~~the~~ a color difference of the ~~two images~~ the input image and a background image stored in advance, and among a plurality of sub-areas included in the second area that is not the background, each sub-area, which includes the center of a sub-area included in the first area that is not the background, is extracted as an area that is not the background, so that the background image is removed from the input image and an area having a motion is extracted.

19.   (Currently Amended) The method of claim 18, wherein in step (a), a new background image R'(x,y) is updated according to the following equation:

$$R'(x,y) = \beta R(x,y) + (1 - \beta)B(x,y)$$

where R(x,y) denotes an existing background image, B(x,y) denotes a binary image in which an area having a motion is removed ~~form~~ from the input image, and β denotes an update constant.

20.   (Currently Amended) A face detection and tracking method for detecting and tracking a plurality of faces in real time by combining visual information of an input image, the method comprising:

obtaining a first area which is not a background by using ~~the~~ a brightness difference of an input image and a background image stored in advance, and obtaining a second area which is not the background[[,]] by using ~~the~~ a color difference of the ~~two images~~ input image and a background image stored in advance, and among a plurality of sub-areas included in the second area that is not the background, ~~and~~ extracting each sub-area which includes the center of a sub-area included in the first area that is not the background, as areas that are not background, to remove the background image from the input image and extract an area having a motion;

generating a skin color probability map (P_{skin}) of the area having a motion[[,]] by using a face skin color model;

extracting a plurality of highest points of the area having a motion, setting central coordinates at a predetermined distance from the plurality of highest points,

and calculating a probability that a face is located within a predetermined distance from the central coordinates, to generate a̲ global probability map (P_{global});

generating a multiple scale probability map about the probability that a face is located[[,]] by multiplying the skin color probability map (P̲$_{skin}$) and the global probability map (P_{global}), and extracting an area, in which the probability value of the generated multiple scale probability map is equal to or greater than a predetermined threshold value, as a candidate area where a face is possibly located~~, to generate a multiple scale probability map~~;

extracting independent component analysis (ICA) features from [[a]] the candidate area and determining whether ~~or not~~ the candidate area is a face area[[,]] by providing the ICA features of the candidate area to a support vector machine (SVM) which has learned features obtained by performing ICA on learning face images and features obtained by performing ICA on images that are not [[a]] face images; and

tracking a face area according to a directional kernel indicating a probability that a face is located in a next frame[[,]] based on the skin color probability map.

21.   (Original) A computer readable medium having embodied thereon a computer program for the method of claim 11.